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The Orientating Response: Habituation, Age, and Stimulus Meaningfulness

by

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A Thesis

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "The Orientating Response: Habituation, Age, and Stimulus Meaningfulness," submitted by Robert Francis Mulcahy in partial fulfilment of the requirements for the degree of Master of Education.

Abstract

The present study examined the habituation of the orientating response with respect to age and stimulus meaningfulness, utilizing a satiation paradigm. Thirty six adults and thirty six children were given, first a discrete (repeated twice) and then a massed (repeated forty times) presentation of three types of stimuli (nonsense syllables, words, and tones). The responses to the stimuli were observed through simultaneous recording of heart rate and galvanic skin responses. Semantic satiation ratings on a set of semantic differentials were obtained for the adults.

The semantic satiation and autonomic measures were submitted to a correlational analysis to investigate the relationship between semantic satiation and habituation. No significant relationship was observed.

The heart rate and galvanic skin responses were separately submitted to analyses of variance. The results show habituation of the galvanic skin response component of the orientating response as a result of repetition. However, habituation of heart rate was not evident in this study. Age differences with regard to amount of habituation were also not obtained. However, age was a factor modifying the heart rate reactions to the three types of stimuli. It was concluded that heart rate responses might

reflect cognitive functioning and as a consequence, offer a viable measure in the study of cognitive activity. A need for further research was indicated.

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Chapter 1

Introduction

This experiment is concerned with the habituation of the orientating response, and examines the manner in which the subject's age and stimulus meaningfulness influence the course of habituation.

The theoretical frame of reference stems from Sokolov's (1960, 1969) stimulus comparison theory of the orientating response. An orientating response is essentially a reaction to encounters with informative stimuli, or stimuli with some degree of novelty. Mismatch between the internalized model and current stimulus input produces "impulses of discrepancy" (Sokolov, 1963, p. 289) along descending fibres triggering an orientating response. It is detectable in many ways: EEG measures, blood volume, heart rate, respiration, galvanic skin conductance, eye movement, and pupil dilation. Repeated presentation of stimuli is normally associated with habituation of the orientating response. Habituation may be indicated by a rapid decrease in skin conductance, decreases in amount of heart rate deceleration to the stimuli, decreased fixation of the eyes, and decrease in amount of pupil dilation. In the present experiment only the first two measures are considered.

Although response decrement differences have sometimes been related to age or differing amounts of

meaningfulness of stimuli, there has been little systematic investigation of developmental changes in response decrement (habituation) to verbal stimuli. Lewis, Goldberg, & Campbell (1969) did explore the response to repeated presentation of a visual stimulus over relatively few presentations. However, their study took into consideration only the first three years of life. They found that habituation was produced by a redundant visual signal during the first three years of life. Younger infants displayed less habituation than older infants. Does this developmental pattern hold for the school-age child when compared with adults? As far as the writer is aware there has been no investigation of differences between children and adults in relation to habituation utilizing meaningful verbal stimuli. Furthermore, most studies of habituation " . . . have often used stimulus intensities strong enough to evoke a defensive reaction initially or within a few trials" (Graham and Clifton, 1966, p. 3011).

This study is therefore concerned with the meaningfulness of the stimuli as an independent variable, along with age as these affect habituation of the orientating response. A further concern is with the parity between changes of the heart rate, and galvanic skin conductance components of the orientating response, as these relate to verbal stimuli.

Chapter 2

Review of Literature

Orientating Response

The orientating response has captured the scientific interest of many authors as evidenced from a growing volume of related literature devoting itself to this concept. Until perhaps 1960 when Sokolov put forth his "neuronal theory" of the orientating response, the concept had received little attention in the Western World. The details of his theory lend themselves readily to empirical investigation and much of the research is designed towards this end. Since 1960, through to the present, a number of publications have addressed themselves to discussion, analysis, and testing of Sokolov's proposals. Only a brief summary of these will be presented here. A more complete description can be found in other sources (Sokolov, 1963; Lynn, 1966). Summary treatments are also available in Berlyne (1960) and Razran, (1961).

The orientating response comprises a set of reactions which may include: increased sensitivity of sense organs, changes in skeletal muscles that direct sense organs, EEG and vegetative changes (Lynn, 1966, p. 2-4). The increase in sensitivity includes such things as pupil dilation and the lowering of auditory threshold. Changes in skeletal muscles include overt bodily reactions such as head movement.

Vegetative changes may include vasoconstriction in the limbs and vasodilation in the head as well as a delay in respiration rate followed by increase in amplitude and decrease in frequency. The galvanic skin conductance increases. Heart rate, according to most researchers, decreases. There is some controversy surrounding the heart rate reaction which will be considered later in this chapter.

This functionally related system of reactions is believed to result from detection of a violation in expected stimulus input, and appears to prepare the organism for better reception of stimuli. It may occur as an unconditioned response or as a conditioned response to signal stimuli (such as a person's name). Thus stimulus change may not be a sufficient condition for elicitation of the orientating response (Berlyne, 1958a, 1961; Campos & Johnson, 1966; Zimny, Pawlick, & Saur, 1969; McCubbin & Katkin, 1971). The results of much of this research suggests that other factors such as set, expectancy, and intensity are also relevant variables affecting the elicitation of the orientating response.

As mentioned before, the most comprehensive model for the orientating response is advanced by Sokolov (1960, 1969). According to his theory, the analysis of incoming stimuli takes place in the cortex, and upon analysis the cortex either excites or inhibits the reticular formation. If the incoming stimuli matches an existing "neuronal model" then the cortex inhibits the reticular formation, and the

orientating response is blocked. Thus if no processing of the stimuli is required the orientating response does not occur. It would occur only if there was a discrepancy between the existing neuronal model and the incoming stimuli.

It would then appear that when information is gained which requires analysis, there is an orientating response (Sokolov, 1969, p. 702). The ticking of a clock soon passes out of awareness. If, however, the ticking changes in some way--if it becomes louder, softer, or ceases--then one is again aware of it. Thus, one becomes habituated to the repeated ticking but dishabituation occurs when the sequency, intensity or some other change is presented.

Several important points can be made concerning the orientating response. The organism compares new incoming stimulation to that which it has previously experienced. If the new stimulus matches the representation of the old one, no processing occurs because the information has already been analysed. Some form of transient memory appears to be involved. Without assuming that memory is involved, it becomes difficult to explain matching of stimuli. Stern (1968) also suggests this in his summary of the orientating response.

Orientating Response and Cognition

Whether or not the orientating response has cognitive status appears to be somewhat debatable at the present time. Bernstein (1969) argues that a perceived stimulus must first be evaluated as potentially significant before an orientation

response will occur. This implies that some cognitive aspect is involved in the orientation reaction. That it is not merely reactive but may reflect active search and thinking is evidenced in studies requiring mental manipulation (Lacey, 1967; Tursky, Schwartz and Crider, 1970). Lewis and Harwitz (1969) argue very persuasively for the position that there are important cognitive components to the orientating response. Their study related the orientation response to tasks involving concept formation in very young children (mean age 44 months ± 3 months). The results of this study support the idea that there are orientating response hierarchies and that they are related to cognitive tasks such as concept formation.

Razran (1961) also argues in favor of a cognitive status for the orientation response; "Yet, there is little doubt that if any such pattern is accorded cognitive status, the orientating response pattern is surely the most likely" (p. 119). He cites the ability of a subject to mentally control some components of the orientating response (transformation from constriction to dilation of blood vessels) in support of his argument.

If cognition is involved, it would seem reasonable to suggest that the orientation response will differ in some aspects depending on the meaningfulness of the material to the subject. Thus meaningful verbal stimuli might be expected to produce a somewhat different orientating response trend upon repetition, than would more meaningless non verbal stimuli.

Habituation of the Orientating Response

Habituation has been defined as response decrement to a repeated stimuli (Harris, 1943; Thompson & Spencer, 1966). It would appear that in many instances the terms habituation, adaptation, accommodation, inhibition, and extinction, are used by different investigators to account for the same general phenomena. Psychologists have shown particular interest in this phenomena because of its importance in inattentive behaviour (Mackworth, 1969).

A complete review of habituation will not be given here as Mackworth (1969) provides an excellent one, using vigilance task experiments to investigate habituation of a repetitive event.

Thompson & Spencer (1966) presented a relatively specific account of the general laws that apply to habituation of the orientating response. A summary of these general laws is as follows:

a. Decrease in response was usually a negative exponential function of the number of stimulus presentations (Faster rate of presentation produces a faster habituation rate).
b. The response recovers when the stimulus is omitted.
c. Habituation is faster for weak stimuli, provided discrimination is not required.
d. Habituation of one kind of stimuli may generalize to another of similar kind.
e. The rate of habituation depends on the regularity

of the stimulus.

f. When the stimulus requires a response or a decision as to whether or not to respond, habituation is delayed (Sokolov, 1963). In such situations habituation may be slower when the discrimination is made.

Current theories of habituation range from very general to molecular levels. In general terms, Thorpe (1956) has suggested that habituation is a general form of learning, while Glaser (1966) has proposed that habituation may play an important part in the adaptation of the organism to his environment. Sokolov's (1963) stimulus-model comparison theory, probably the best known and most frequently investigated analysis of habituation, is at the general neural systems level, as is Hernandez-Peon's (1960) theory of afferent neuronal inhibition. Thompson and Spencer (1966) developed the view that response habituation depends on the equilibrium of two processes, one decremental in nature and the other excitatory in nature. Horn (1967) presented a somewhat similar view. Groves and Thompson (1970) put forth a dual-process theory of habituation relying on experimental evidence derived from studies on *spinal* cats. The difficulties associated with extrapolation of results obtained from a spinal cat to habituation in humans with intact higher nervous systems makes their theory regarding response habituation quite speculative.

Habituation in terms of Sokolov's theory is associated

with the development of a "model" of the "stimulus" somewhere within the cortex. The model is changed and refined upon repeated application of the stimuli. When the "neuronal model" matches the incoming stimuli the cortex inhibits the reticular formation and the orientating response is blocked. In view of Sokolov's theory, if one is repeatedly exposed to a stimuli the neuronal model becomes more clearly differentiated with regard to all aspects of the stimuli (temporal, spatial and intensity). Habituation then occurs more rapidly with a familiar stimuli than with an unfamiliar stimuli and/or one which has little meaning as a result of possible lack of exposure. Thus experience with the stimuli should be a crucial factor in the rate and amount of habituation one observes.

Much of the research aimed at delineating the characteristics of habituation of the orientating response have not controlled for differences between an orientating response and a defense or startle response (Davis, Buchwald and Frankman, 1955; Lang and Hnatiow, 1962; Groves and Thompson, 1970). In some cases stimulus intensities may have been strong enough to evoke a defensive reaction. Studies have shown that habituation of the orientating response differs markedly from habituation of a defensive reaction (Raskin, Kostes, Bevers, 1969) with the defensive reaction much slower to habituate than the orientating response.

Horowitz (1970) assessed the habituation of cardiac

responses of six month old male infants in the presence of both familiar and discrepant auditory stimuli. All of the infants displayed progressive habituation of the cardiac deceleration response in the presence of a repetitive stimulus consisting of two contiguous tones.

In a second-by-second analysis of heart rate, Myers (1970) found significant deceleration of heart rate to a moderate (70db) and a loud (95db) tone in 11-13 year-old children. The (70db) tone upon repetition displayed significant habituation of the deceleration component of heart rate. The results were consistent with Sokolov (1960) in that a nonfamiliar stimuli will produce an orientating reaction and subsequent deceleration of heart rate. The loud tones (95db) however, upon repetition, displayed a significant decelerative component which resisted habituation. As a result of this study, Myers (1970) suggests that Graham and Clifton's (1966) hypothesis that heart rate deceleration as a cardiac component of the orientating response, should be restricted to unfamiliar stimuli.

The childrens' responses in Myers' (1970) study, different from the adult responses observed by Myers and Gullickson (1967). Both studies used the same procedure and stimuli. In their 1967 study the reversal of the 70db tones produced reliable cardiac deceleration in the adults but the children did not display this dishabituation upon reversal. They conclude that the nature of the age differences is unclear. The children could conceivably have been less

perceptive than the adults to the changes in tonal pattern. It is, however, somewhat fallacious to look at two different studies and draw conclusions about age differences when the environmental situations surrounding each may have been quite different. Even though each study was a replicate of the other in terms of stimuli and measures, the conditions within the studies could have been quite different (atmosphere, experimenter, situation, etc.). To draw valid conclusions a study which incorporates age differences within it, in relation to habituation, would be more appropriate.

Lewis, Campbell and Goldberg (1969) dealing with infants (ages of three months to three years) conclude that "(a) response decrement is produced by a redundant visual signal during the first three years of life; and (b) the degree of this response decrement follows a developmental pattern, with younger infants showing less decrement than older infants" (p. 30). These results are based primarily on visual fixation data although one study incorporated heart rate measures. In this study there were no significant differences in heart rate deceleration as a result of repetition. The heart rate acceleration component also displayed no habituation for any of the five age groups (12 weeks, 24 weeks, 36 weeks, 56 weeks, 68 weeks).

Bower and Das (1972) in a study of the orientating response to words and nonsense syllables of normal and retarded children found only minimal habituation of heart rate where Myers (1969) and Lewis, Goldberg & Campbell (1969) had

found rapid habituation employing nonverbal signals. In the former study, however, the children were much older than the subjects in the two latter studies.

An interesting aspect of heart rate trends in relation to the orientating response is put forth by Lacey (1959). He found that when the subject is required to take in external stimuli there is an initial heart rate deceleration, yet when required to internally think, there is heart rate acceleration. Recent evidence supports this (Tursky, Schwartz & Crider, 1970; Schwartz, 1971). Porges & Raskin (1969) noted that when college students were asked to attend to an internal task, such as counting their own heart beats, acceleration occurred.

Taylor & Epstein (1967) investigated covariation of heart rate and skin conductance in humans under varying stimulus conditions. Their investigation revealed no consistent relationship between heart rate and skin conductance response. The relationship among the response measures appeared to depend somewhat upon specific characteristics of the stimuli. Cohen & Walter (1966) found that responses (as monitored by EEG ratings) to symbolic and meaningful semantic stimuli (visual shapes) are differentiable from responses to clicks and flashes. This would seem to indicate that one might expect a different trend in the orientating response when utilizing meaningful verbal stimuli.

To sum up, the literature reviewed up to this point shows that little information beyond the Bower and Das

studies is available on habituation of the orientating response in relation to complex verbal stimuli, such as words or nonsense syllables. But it seems theoretically sound to expect that words or nonsense syllables should habituate more slowly than simple stimuli such as light flashes and tones. The few studies that have used verbal stimuli in habituation experiments have not considered child/adult differences in habituation. Although some differences in habituation have been related to age, the majority of these have been concerned with the first few years of life.

The review also shows that besides stimulus meaningfulness and age, another neglected aspect of orientating response studies is the disparity between galvanic skin response and heart rate (Lacey, 1959) in relation to verbal stimuli. Heart rate appears to depend on stimulus characteristics (Bower & Das, 1972) whereas the galvanic skin response might be an index of autonomic arousal confounded with the orientating response.

Semantic Satiation as OR Habituation

Semantic satiation is usually defined as the loss of meaning of a word following either (overt) verbal repetition, prolonged visual inspection, or repeated writing of the word (Esposito & Pelton, 1971, p. 330). While words, when repeated, usually lead to a decrement in meaning, ambiguous stimuli such as underexposed pictures may gain in meaning (Jakobovits & Lambert, 1964). The loss of meaning is called semantic satiation and a gain of meaning is referred to as semantic generation (Das, 1969, p. 99).

The observation that semantic generation occurs in

certain instances (ambiguous stimuli), has proven difficult to explain in terms of an inhibition theory (Lambert & Jakobovits, 1960). If cognitive inhibition is responsible for semantic satiation, then an increment in meaning should not occur as a result of repetition. One should consistently obtain semantic satiation regardless of the ambiguity of the stimuli.

Esposito & Pelton (1971) in a selected review of the literature related to the measurement of semantic satiation, suggest that verbal transformation results in semantic satiation. They propose that ". . . the original percept of the word is no longer being experienced, and the percept which replaces the old one is meaningless" (p. 343). The indication being that one should measure semantic satiation through subjective reports (a highly unreliable method). This proposal would appear to the writer to be subject to the pitfalls of an inhibition theory. If perceptual reorganization is involved in semantic satiation, then why does one obtain generation of meaning with respect to specific types of stimuli?

An intriguing hypothesis concerning semantic satiation with respect to habituation of the orientating response has been suggested by Das (1969). In general, he proposes that overt repetition of a stimulus such as writing, oral or auditory, results in habituation of the orientating response (loss of attention). Thus he would define semantic satiation in terms of a loss of attention (habituation), rather than a

loss of meaning.

There are considerable similarities in the conditions giving rise to semantic satiation and habituation of the orientating response. Repetition of a stimulus, in most cases, results in satiation and also in habituation. The conditions giving rise to semantic generation (ambiguous stimuli) also appear to give rise to a maintaining of the orientating response (Sokolov, 1963, p. 166). If discrimination is involved in semantic satiation studies (Lambert & Jakobovits, 1960) or in orientating response studies (Thompson & Spencer, 1966) the general finding is one of no satiation and little habituation.

Additional evidence suggesting that loss of attention may be related to semantic satiation comes from experiments on vigilance tasks (Das, 1964). The results suggest that there is a high positive relationship between poor vigilance and low satiation scores. This could conceivably indicate that those who cannot attend readily do not satiate very rapidly.

The measurement of semantic satiation has become open to question (Esposito & Pelton, 1971). The methods which have been used have usually been concerned with meaningfulness and semantic satiation. The measures employed have included such things as communality of associates (after treatment, subject is given an associate to the test stimuli), semantic differential (subject rates the word on a scale), number of elicited associations to the test word, decision latency

(longer the latency, greater the satiation), and search time (subject is required to find the satiated word in a list of others). In reviewing the results of these different methods of measuring semantic satiation, Esposito & Pelton, (1971) conclude as follows: "The several methods of measurement which have been used to assess the effects of repetition on the meaning of words have yielded questionable results" (p. 341).

If habituation of the orientating response is shown to follow the same general findings as those in semantic satiation studies (using similar procedures), then one may have an objective measure of semantic satiation. This could contribute to the reliability of research on semantic satiation, specially when young children and mental retardates are included as subjects.

In the present study, it is planned to explore the possibility that semantic satiation is a result of adaptation of the orientating response to the word. Suggestion in this regard is found in Sokolov (1960) who has observed that "Following the habituation of a response to a word, another of similar semantic meaning does not evoke an orientating reflex, whereas a word of a different meaning does" (Sokolov, 1960, p. 207).

Chapter 3

Rationale, Definitions, and Hypotheses

Rationale

A close examination of the literature failed to reveal any studies investigating the relationship between; age, habituation, and stimulus meaningfulness. In fact only two studies (Bower & Das, 1972; Das & Bower, 1971) employed meaningful verbal stimuli in investigating habituation of the orientating response. However, neither of the two studies included age as a variable within the investigation. Those studies which have included age as an independent variable (Fantz, 1964; Lewis, Goldberg & Campbell, 1969) have considered only the first few years of life. The literature therefore allows for only minimal comparisons between young children and adults with respect to habituation of the orientating response.

Lewis (1967) suggested that habituation is related to central processes and therefore has significance in the assessment of early cognitive development. If habituation is related to cognitive development as other authors have suggested (Lewis & Harwitz, 1969, Jennings, 1971) then differences in habituation should be observed between children and adults when utilizing meaningful verbal stimuli.

The controversial topic of heart rate responses to varying types of stimuli (Graham & Clifton, 1966; Lacey,

1969) would appear to hold promise for indicating cognitive activity within the organism. There is therefore a need to examine more closely the measures of heart rate and galvanic skin response in relation to meaningfulness of the stimuli and age (as this reflects cognitive development).

Specific Objectives

The specific objectives of the study are to examine:

1. the similarity of habituation across different stimuli.
2. possible age differences in the degree of habituation
3. relationship among galvanic skin response, heart rate, and satiation measures derived from the semantic differential.

Definitions

General Terms

Orientating response. A system of sympathetic, skeletal and other changes, essentially involving the whole body, which constitute a reliable reaction to the stimulus condition of discrepancy or expectancy (stimulus change). The reaction occurs relatively independently of the direction of the stimulus and habituates under continuing repeated presentation of a stimulus. The term is synonymous with orienting response, and is abbreviated as OR.

Component of OR. Any one of the sympathetic skeletal or sense organ changes (e.g., heart rate deceleration, eye movement, galvanic skin response) which is a regular part of the reactions comprising the OR.

Phasic response. A rapid change in a component of OR which returns within a few seconds to the original level, and which is a response to some aspect of the environment.

Habituation. Decline in amplitude of the OR as a function of repeated presentation of a stimulus. The decline may continue to the point where no response occurs at all.

Semantic satiation. Habituation of the OR as a result of repeated presentation of a verbal stimuli.

Trial. A discrete presentation of the stimulus following its repetition.

Galvanic Skin Response Measures (GSR)

Second by second conductance change. Difference between mean conductance observed at one second intervals for the two seconds immediately preceding stimulus onset and eight one second intervals following stimulus onset. In the study there were therefore eight difference scores obtained for each subject on a trial.

Magnitude. Maximum change in (natural) logarithm conductance, within the one to five second period immediately following stimulus onset.

Frequency. Number of scorable galvanic skin responses. Each subject given a score of one if the

downward pen deflection is equivalent to or greater than 5 hundred ohms. Response must occur between one and five seconds after stimulus onset.

Heart Rate Measures (HR)

Second by second change. Difference between mean beats per minute observed at one second intervals for the two seconds immediately preceding stimulus onset and the eight one second intervals following stimulus onset. In the study there were eight difference scores obtained for each subject on a trial.

Percent deceleration. Percentage decrease in heart rate. % Decrease= 100 x (Prestimulus beats per minute-mean of the two lowest beats per minute in the next five seconds)/Prestimulus beats per minute.

Percent acceleration. Percentage increase in heart rate. % increase= 100 x (highest beats per minute between fourth and eighth second following stimulus-prestimulus beats per minute)/prestimulus beats per minute.

Rationale for Response Measures

There is a continuing debate concerning the most appropriate measures for many of the physiological responses. As far as the galvanic skin response is concerned, the common practice is to measure the amplitude of GSR (Darrow, 1964, 1967; Haggard, 1949; Martin, 1964). Magnitude is preferred to amplitude in this study, because amplitude is

considerably affected by missing scores which tend to occur with habituation. Magnitude, because it takes into account zero responses in reaching a mean would therefore be a more sensitive measure than amplitude which ignores zero responses.

The magnitude measure is more sensitive than a frequency measure. A frequency score ignores variations in amount of responsitivity as a score of one is obtained regardless of whether or not the change is 5 hundred ohms or 7 hundred ohms. The magnitude score however, does take into account the differences in amount of conductance change as it varies above the 5 hundred ohm level. Therefore, although a frequency score and a magnitude score is related, the magnitude score would be preferred.

A second by second analysis of conductance change was taken in order to look at the meaningful relations existing between galvanic skin responses and the experimental manipulations. Graham & Clifton's (1966) discussion of heart rate analysis points out the importance of looking at second by second, and trial by trial heart rate changes in order to elucidate the meaningful relations between heart rate change and the experimental variables. This could also be said of the galvanic skin response measures.

One difficulty surrounding heart rate measures is the problem stated in the "Law of initial values" (Lacey 1959). The "law" states that response to an excitatory stimulus

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

decreases and response to an inhibitory stimulus increases as the level of activity of stimulation increases. This seems to mean that whether stimuli generally evoke heart rate acceleration or generally evoke heart rate deceleration, the change from high prestimulus levels will be negative. However, Graham & Jackson (1970) studied this phenomena in some detail. They suggest that when the only interest lies in the direction of heart rate change, it usually proves satisfactory to use unadjusted difference scores. As the present study is concerned primarily with the direction of change, i.e., heart rate deceleration and acceleration, it does not seem inappropriate to use the unadjusted difference score as one of the measures of heart rate.

The measurement of heart rate in real time units (beats per minute) rather than in cardic cycles (successive beats) has been debated. Graham & Jackson (1970) suggest beats per minute as the measure because "they appear better suited to comparisons across age groups whose base heart rates differ markedly . . ." (p. 72). Since this study is concerned with comparisons across two age groups a beats per minute measure was chosen over a beat by beat measure.

It should be pointed out that the heart rate measures chosen and the scoring procedures used, reduce, but do not completely eliminate the influence of prestimulus level differences.

The polarity difference score in the semantic differential is a standard measure of semantic satiation (Lamberts & Jakobovits, 1960). There are many problems involved in using the semantic differential (Das, 1969, Esposito & Pelton, 1971). The polarity difference score does not measure radical changes in meaning. This method is aimed at detecting loss in intensity of meaning and since this study is concerned with loss of meaning, then mere shift is irrelevant for purposes of the study. If the study had been concerned with <u>meaning</u> then another scoring procedure may have been used to detect shift in meaning.

Hypotheses

Jachuck (1966) in studying semantic satiation in young children (8 - 10 years) and adults (20 - 22 years) obtained a significantly greater satiation effect for the adult group. If habituation of the orientating response (loss of attention) results in what has to date been referred to as semantic satiation then children in the age range of 8 to 10 years could be expected to show less habituation of the orientating response to verbal stimuli than adults.

Das (1969) in discussing semantic satiation comments that ". . . one may observe that nonsense syllables, inappropriate scales, and ambiguous material are in the category which favor semantic generation" (p. 101). Therefore if stimuli such as words, nonsense syllables and tones are used, then one should observe a greater satiation effect

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

(habituation) for tones than for words or nonsense syllables. The nonsense syllables being probably the most ambiguous of the three stimuli should display the least habituation.

If one considers Sokolov's theory of the orientation response in relation to habituation, then children would display less habituation to a familiar word than would adults, because the adults have more experience in relation to the word than the children. There would therefore be less discrepancy between the existing neuronal model and the external stimuli.

In relation to habituation of the orientating response to nonsense syllables one could expect that within the adult or children groups there would be less habituation to these than to words or tones, there being no neuronal model with which to compare the nonsense syllable with.

On the basis of the above the following hypotheses were formulated:

Hypothesis 1. Habituation of the orientating response will occur upon repetition in both children and adults.

Hypothesis 2. Children will display less habituation of the orientating response than will the adults. Percentage of deceleration and acceleration of heart rate and magnitude change in the galvanic skin response will decrease as a result of repetition. This decrement will be greater for adults than for children.

<u>Hypothesis 3</u>. There will be more habituation of heart rate and galvanic skin response for tone than for the word or nonsense syllable. This will occur for both children and adults.

<u>Hypothesis 4</u>. The nonsense syllable will show the least habituation of orientating response as compared to word or tone. This will be found in both children and adult groups.

<u>Hypothesis 5</u>. There will be a significant correlation between semantic satiation as measured by the semantic differential and decrements in heart rate and galvanic skin response.

Chapter 4

Methods

Subjects

Two populations were involved in the proposed investigation, viz., adults and normal children. The children were volunteers from two city elementary schools. Those children whose school records suggested evidence of sensory (auditory) emotional or organic anomalies or medically diagnosed skin conditions were excluded from the study. The records of four subjects were not included in the final sample due to incomplete data and failure in operation of the polygraph. The final sample comprised 36 children having a mean chronological age of 10.3 years (SD = 0.9). All of the subjects were males.

Thirty-nine paid students (volunteers) from undergraduate psychology courses in Educational Psychology comprised the second group. Students sustaining any defects in hearing, or medically diagnosed skin conditions were not accepted. The records of three adult subjects were omitted from the final sample, two because of failure in operation of the polygraph and one was randomly discarded to have an equal number of subjects. The final sample included 36 subjects having a mean chronological age of 22.7 years (SD = 3.9 years). All subjects were male.

<u>Apparatus</u>

A Hewlitt Packard model 1500 polygraph was used for recording galvanic skin responses and heart rate responses. Three channels were used: One to measure the galvanic skin response, one to measure heart rate, and one to record the audio-signals from the tape recorder. The paper ran at a constant speed of five mm. per second, thus making is possible to determine the temporal location of each stimuli presentation.

To obtain galvanic skin response readings, silver electrodes 0.5 inches in diameter were attached to the subject's left palm, back of the left hand, and a ground placed approximately eight inches from the wrist of the left arm. The heart rate measures were obtained from silver electrodes placed on the sternum and the third rib on the left side of the body, with a ground secured to the right wrist. The flat electrodes were filled with Beckman paste and were attached by electrode adhesive collars.

The auditory stimuli and instructions were supplied through a speaker on the wall, located above the subject's head. Subjects sat in a padded leather chair with wide arms, separated from the experimenter by an electrically shielded, soundproof room. Artifacts resulting from movement could be detected through a one way mirror built into the booth, and were marked on the subject's record.

Experimental Design

The paradigm employed in the present study to produce habituation, differs from the usual procedure. In typical studies of habituation, the procedure is to present the test stimulus repeatedly, allowing for intertrial intervals in which to take physiological measures. Repetition continues until a criterion of habituation is reached. The present study utilized a satiation procedure (Das, 1969) as the intent was to investigate the amount of habituation rather than the rate. A satiation paradigm for adult subjects essentially involves the presentation of the stimulus once and rating it on a set of semantic differentials. The subject is then required to repeat it for a specified period of time. At the end of repetition, a final rating is obtained. The difference of the two ratings are then taken as an indication of satiation. Since children are not usually capable of filling out rating scales, they are only required to repeat the stimulus. This study attempted to examine the relationship between habituation of the orientating response and semantic satiation. Consequently it would seem appropriate to use a satiation procedure.

Three kinds of stimuli were used: Tones (600cps and 1,000cps), words (love and friend), and CVCs (yuf and zuk). For one-half of each group of subjects the 600cps tone, love and yuf, were repeated forty times, whereas the other items in the stimulus pairs were repeated only two times. This was counterbalanced for the other half of the group. Following the discrete (repeated twice) condition, five separate

presentations (trials) of the stimuli was made. The same procedure was followed for the massed (repeated forty times) conditions. Repetition interval was .5 seconds, and it took approximately one second to repeat a stimulus once. The interval between the end of repetition and the first five individual presentations was varied between 17 and 22 seconds, which was also the intertrial interval for the remaining presentations.

Thus each of the three stimulus classes had an item for massed and another for discrete presentations resulting in six stimulus conditions. They were randomly presented with the stipulation that the three discrete presentations always preceded the massed presentations. Galvanic skin responses and heart rate responses, evoked by the five individual presentations following repetition, were recorded in order to examine the course of habituation of the orientating response.

For the adult group the semantic differential scale was administered prior to the stimulus presentations. The six stimuli were played through the speaker and the subject was required to mark on the three adjective scales (see appendix A) what he thought the stimuli meant to him at that time. The same procedure was followed after presentations of the six stimulus conditions.

Procedure

A male experimenter and a female assistant conducted

the experiment. The voice of the experimenter had been used on tape for the recording of the stimulus and instructions.

When the subject entered the laboratory, he was given a brief description of the equipment and permitted to ask questions about it. No specific indication of the nature of the study was given. The subject was then seated on an adjustable padded chair while the experimenter described the attachment of the galvanic skin response and heart rate electrodes. At the same time, the assistant prepared the site of electrode placements and made the attachments. In all, a minimum of eight minutes elapsed between attachment of electrodes and the presentation of the first stimuli. Each subject was given approximately four minutes in which to stabilize the readings of galvanic skin resistance and heart rate before actual recording of responses began. For adult subjects this was done while the subject was completing the semantic differential task.

Subjects were asked to merely listen to the stimuli. No response was required, as this would destroy the repetition effect by bringing back the orientating response. The following instructions on tape were given: "Now I want you to sit quietly and listen to some words and tones. You will hear the words love, friend, yuf and zuk. Sometimes they will be said more than once - like love, love, love, love or zuk, zuk, zuk, zuk. OK!. Just listen to them." The recording procedure took approximately 20 minutes to complete for the children and 25 minutes for the adults.

Scoring Procedure

All raw data were manually scored in terms of the criteria previously listed. All raw response measures were transferred to punched cards and transformed into difference scores. These were then utilized in the analysis.

Within the galvanic skin response phase the following measures were used for each subject:

1. One-hundred-twenty second x second conductance measures, ten for each stimulus condition and ten for each of trials, one and five within each stimulus condition.
2. Twelve magnitude measures, six for each stimulus condition and two corresponding to each of trials one and five within the stimulus condition.
3. Twelve frequency measures, corresponding to the stimulus conditions and the two trials.
4. Ninety-six second x second difference scores derived from 1.

Within the heart rate phase the following measures were used for each subject:

1. One-hundred-twenty second x second heart rate measures. Same as for galvanic skin response measures.
2. Ninety-six heart rate difference scores taken second x second.
3. Twelve % acceleration scores derived from the raw scores of 1.

4. Twelve % deceleration scores derived from the raw scores of 1.

This scoring method does not appear to be subjected to the pitfalls that Graham & Jackson (1970) mention. They are critical of procedures where, for example, "the three fastest beats of a five second prestimulus period are compared with the three fastest beats of a ten second post stimulus period . . ." They observe that such comparisons are fallacious: "Stated in more general terms, if a fixed number of external observations (e.g. 3) is selected from periods of unequal size (e.g. 5 & 10 observations), the selections will necessarily include different proportions of each period (e.g. 60 & 30 %). Obviously if the two periods have identical means and variances, values in the upper 30% of a period will be larger than values in the upper 60% (p. 74)."

The procedure used in this study was to take the two lowest beats within one to five seconds after stimulus onset and the two highest beats within four to eight seconds after onset of stimulus. A percentage change was then calculated using the mean of the first two second readings before stimulus onset. The percentage measure was used to equate the prestimulus levels and provide a common scale for change. Thus, fastest or slowest beats were not selected randomly and it would seem that the percentage change score merely sharpens the trend obtained in the averaged heart rate curve and lends itself to statistical

treatment.

Within the semantic differential phase the following scores were used for each adult subject:

1. Twelve sums taken for each stimulus condition. Six sums pre-experimental and six sums post experimental.

2. Six differences scores based on the experimental minus the post experimental sums. One score derived for each stimulus condition.

Various methods have been suggested for the treatment of physiological artifacts, and a number of these have been summarized in a fairly recent paper (Sternback, Alexander, Rice & Greenfield, 1969). There were very few artificats (mainly movement) occurring in the sample of galvanic skin response and heart rate data.

Chapter 5

Analyses and Results

Galvanic Skin Response

The general design involved two subject groups (adults and children), two presentations (discrete and massed), three types of stimulus (nonsense syllables, words, and tones), two trials (the first and the fifth), and eight conductance difference scores. This gives rise to a 2 x 2 x 3 x 2 x 8 factorial design with repeated measures taken over the last four factors. An initial check for counterbalancing of the types of stimulus was carried out. As no significant differences were obtained (children: F= .04, df= 1,36; adults: F= .14, df= 1,36), the groups were combined for all further analysis.

Second by second conductance change. A 2(groups) x 2(discrete/massed) x 3 (stimuli) x 2(Trials) x 8(sec. x sec.) analysis of variance with the last 4 factors repeated, was performed utilizing the sec. x sec. conductance change scores as the dependent variable. Table 1 presents a summary of the analysis. Figures 1 & 2 present the means of the two groups collapsed over the discrete/massed and the trials dimensions.

The results of the analysis indicates a significant main effect for stimulus (F= 5.63, df= 1,70, P< .01). The indication being that the nonsense syllables effected the

Table 1

Analysis of Variance GSR sec x sec Conductance Difference Scores

Source	df	M.S.	F-ratio
Between	71		
Group (A)	1,70	18.21	NS
Error	70	22.81	
Within			
Discrete/massed (DM)	1,70	6.42	NS
D M x A	1,70	7.55	NS
Error	70	8.40	
Stimuli (S)	2,140	18.25	5.63**
S x A	2,140	2.51	NS
Error	140	3.24	
Trials (T)	1,70	1.85	NS
T x A	1,70	21.69	5.10**
Error	70	4.25	
Seconds (SC)	7,490	20.05	17.22***
SC x A	7,490	1.33	NS
Error	490	166	

*P< .05

**P< .01

***P< .001

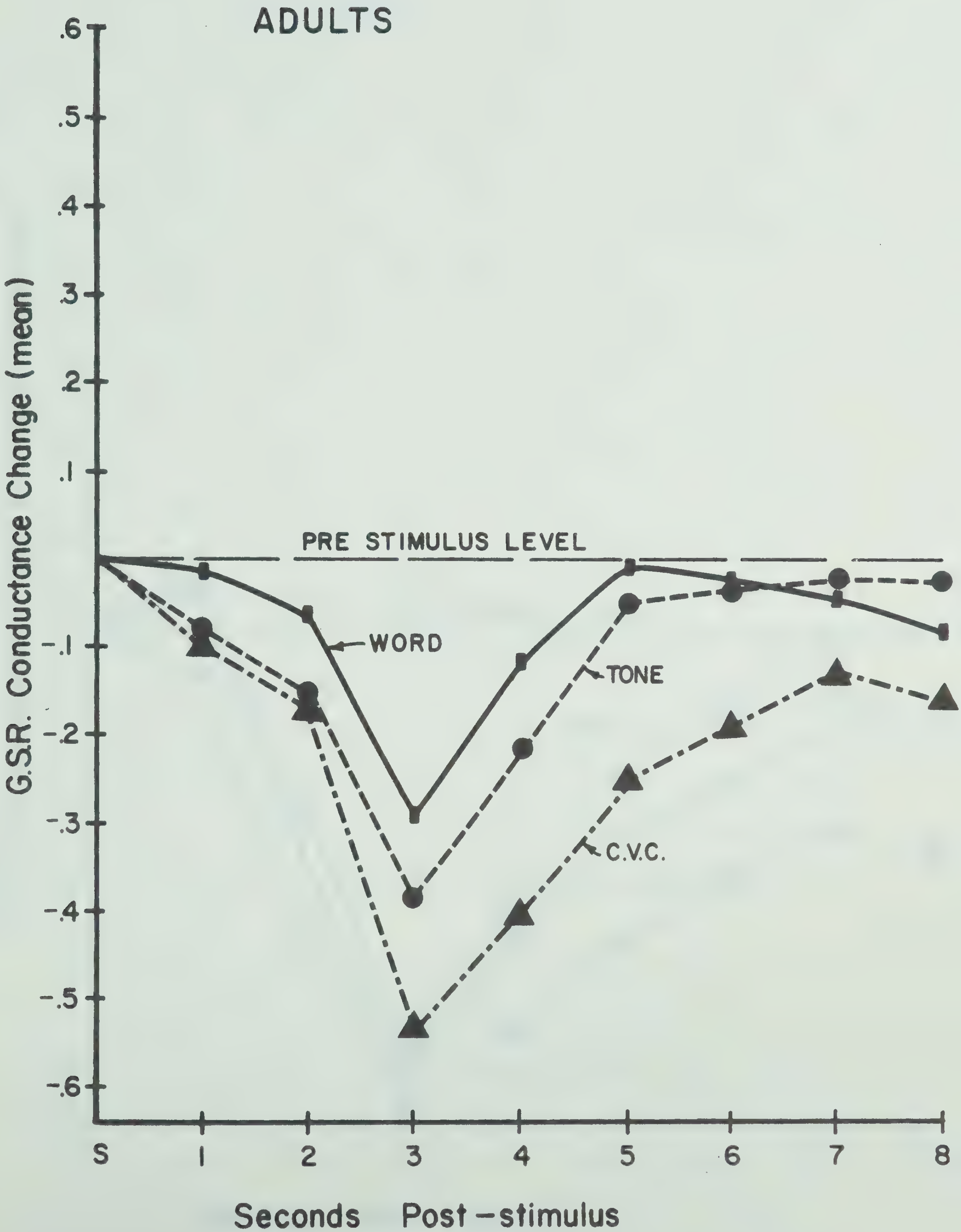
ADULTS
.6
.5
.4
.3
.2
.1
-.1
-.2
-.3
-.4
-.5
-.6
G.S.R. Conductance Change (mean)
PRE STIMULUS LEVEL
WORD
TONE
C.V.C.
S
1
2
3
4
5
6
7
8
Seconds Post-stimulus

Figure 1

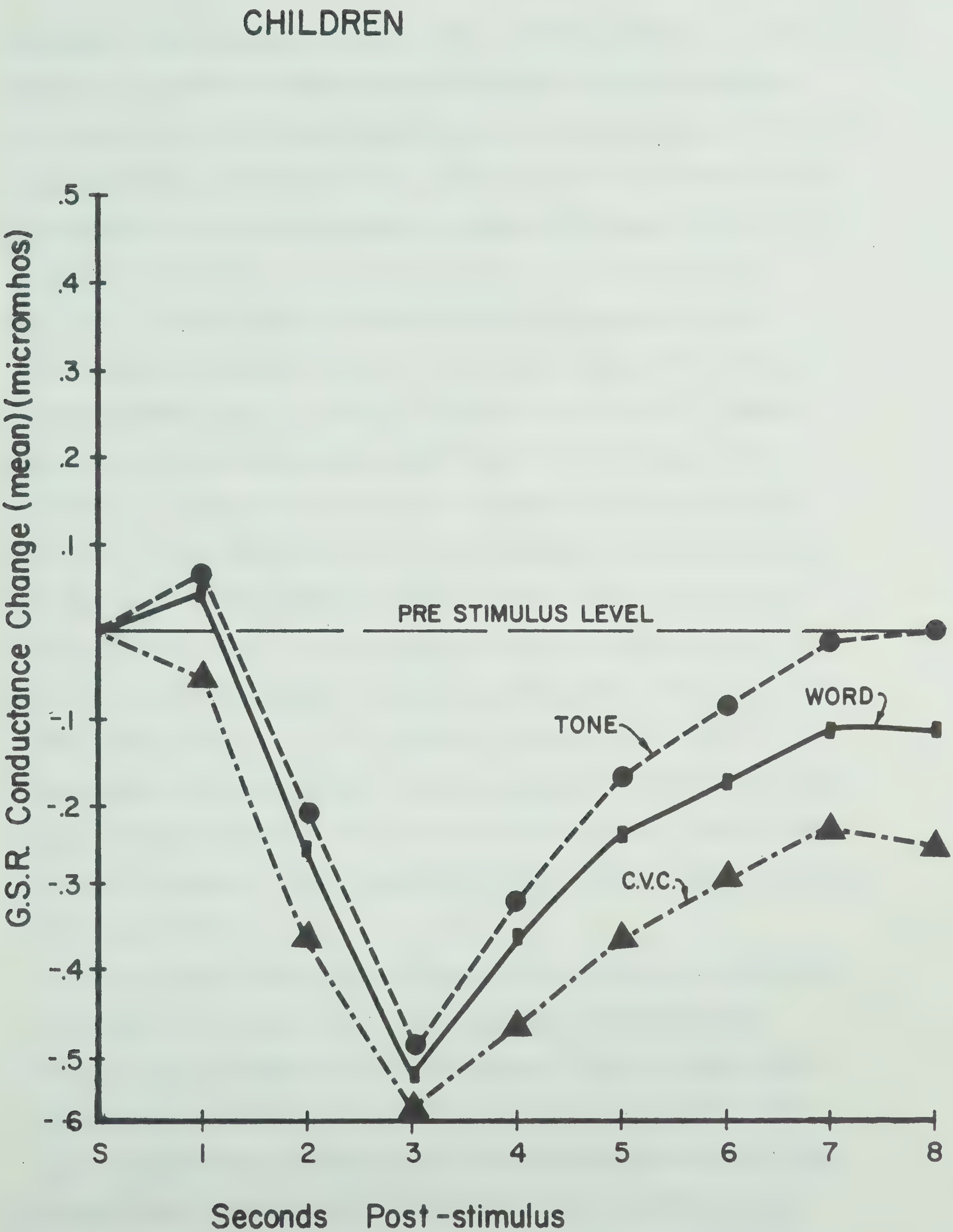
CHILDREN
G.S.R. Conductance Change (mean) (micromhos)
.5
.4
.3
.2
.1
-.1
-.2
-.3
-.4
-.5
-.6
PRE STIMULUS LEVEL
TONE
WORD
C.V.C.
S
1
2
3
4
5
6
7
8
Seconds Post-stimulus

Figure 2

greatest conductance change. This effect appears to be a result of greater responsivity to the nonsense syllable by the adults. Further analysis utilizing correlated *t* tests revealed that the significant main effect for stimulus was due mainly to the differences between the word and the nonsense syllable in the adult group ($t= 2.83$, $df= 35$, $P< .03$). There were no significant differences found within the childrens group. To further check for differences between the two groups Scheffe's Multiple *t* tests were carried out using the 3rd second as the dependent variable. The only significant finding was for the word ($P< .04$). The children were significantly more responsive to the word in the massed presentation. The means were -.74 and -.11 for the children and adults respectively.

The significant interaction of groups x trials ($F= 5.63$, $df= 2,140$, $P< .01$) is quite interesting, the indication being that the adults adapted out their responses from the first to the fifth trial to a greater extent than did the children. The respective means were; -.90, -.17 and -.329 and -.160.

A significant main effect for seconds was obtained ($F= 17.22$, $df= 7,490$, $P< .001$) suggesting the typical galvanic skin response of an increase in skin conductance followed by a return to prestimulus level (Figure 1 & 2). It is interesting to note that the two groups reached their maximum skin conductance change at about the 3rd second.

The results of the sec. x sec. conductance change

analysis revealed no significant differences in relation to habituation between the children and the adult groups. The sec. x sec. conductance change analysis therefore does not lend support to the hypothesis that adults would display greater habituation than the children (Hypothesis 2).

Magnitude (Log_e Conductance Change)

A 2(groups) x 2(discrete/massed) x 3(stimuli) x 2 (trials) analysis of variance with the last three factors repeated, was performed on the magnitude measures. The results of this analysis is presented in Table 2. Figure 3 presents the means of the adult and children groups.

A significant main effect was found for the discrete/massed dimension ($F= 11.81$, $df= 1,70$, $P< .001$). It would seem to be indicated here that habituation occurred as a result of repetition. The means were .390 and .296. Thus overall habituation occurred for both groups as a result of repetition. Support is found here for the hypothesis that habituation would occur for both groups as a result of repetition (Hypothesis 1). There being no significant interaction of groups x discrete/massed it was deduced that the children were not habituating their responses more or less than the adults. As in the second by second conductance change analysis no support is found for Hypothesis 2.

The main effect obtained for types of stimulus ($F= 3.02$, $df= 2,140$, $P< .05$) indicates some differential response to the different types of stimulus. The effect

Table 2

Analysis of Variance GSR Magnitude
($\log_e$ Conductance)

Source	df	M.S.	F-ratio
Between	71		
Group (A)	1,70	0.02	NS
Error	70	1.02	
Within			
Discrete/massed (DM)	1,70	1.94	11.81***
DM x A	1,70	0.15	NS
Error	70	0.16	
Stimulus (S)	2,140	0.48	3.017*
S x A	2,140	0.02	NS
Error	140	0.16	
Trials (T)	1,70	0.91	5.56*
T x A	1,70	0.54	3.33
Error	70	0.16	

*P< .05

**P< .01

***P< .001

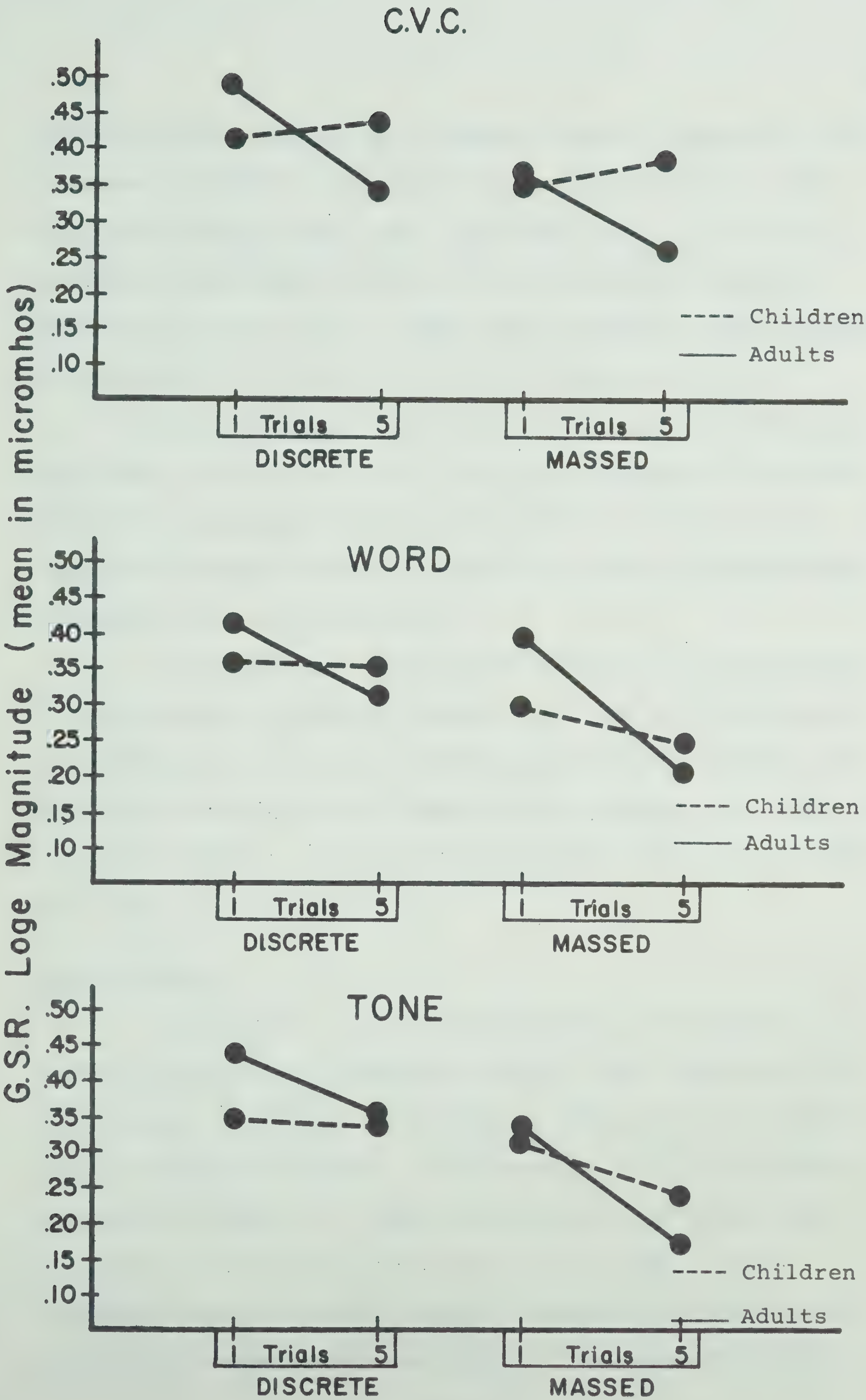
C.V.C.
WORD
TONE
G.S.R. Loge Magnitude (mean in micromhos)
.50
.45
.40
.35
.30
.25
.20
.15
.10
---- Children
—— Adults
1 Trials 5
DISCRETE
MASSED

Figure 3

appears to be a result of a greater overall response to the nonsense syllable as compared to the word or tone. The respective means were; .390, .324, and .315. Thus the somewhat meaningless verbal stimuli produced a greater response in both groups. This result supports that obtained in the second by second conductance change analysis.

The significant main effect obtained for the trials condition ($F= 5.56$, $df= 1,70$, $P< .05$) suggests an adapting out of the response from the first to the fifth trials. The respective overall means collapsed over the discrete/massed dimension were; .390 and .296.

An interesting result is displayed in the responses to the nonsense syllable (Figure 3.). The adults display an adapting out of their responses over trials whereas the children display a slight tendency to increase the magnitude of their response. However this did not reach significance ($F= 3.33$, $df= 1,70$, $P< .08$).

<u>GSR Frequency</u>

A 2(groups) x 2(discrete/massed) x 3(stimulus) x 2 (trials) analysis of variance with the last three factors repeated was performed utilizing the frequency of response as the dependent variable. The results of this analysis is presented in Table 3. These indicate a significant main effect for groups ($F= 6.79$, $df= 1,70$, $P< .025$). The children display greater overall frequency of response to stimulus as compared to the adults. The respective means

Table 3

Analysis of Variance GSR Frequency

Source	df	M.S.	F-ratio
Between	71		
Groups (A)	1,70	5.51	6.80*
Error	70	0.81	
Within			
Discrete/massed (DM)	1,70	8.36	35.30***
DM x A	1,70	0.14	NS
Error	70	0.24	
Stimuli (S)	2,140	0.44	2.30
S x A	2,140	0.22	1.41
Error	140	0.19	
Trials (T)	1,70	1.95	9.45**
T x A	1,70	0.72	3.51
Error	70	0.21	

*P< .05

**P< .01

***P< .001

differences obtained to indicate that the adults habituated to a greater extent than the children. But habituation was clearly obtained as a result of repetition even if a satiation design was used, and the findings here follow those obtained in other studies of habituation (Bower & Das, 1972; Una & Grings, 1965) in that repetition results in a decrease in skin conductance.

The presentation of differing types of verbal stimuli gives rise to differing levels of magnitude of galvanic skin response. The findings in the galvanic skin response analysis thus lends some support to Hypothesis 4: a greater response to the nonsense syllable was evident in both groups. In (Figures 1 & 2), the GSR magnitudes of adults and children are compared. If one considered this in relation to Sokolov's (1960) neuronal model, the disparity could be explained in terms of distinct differences between the models used by children and adults respectively in processing the words presented. The adults had a clearer neuronal model of the word as a result of more contacts with the word through experience than the children. As a result the children responded to the word much like adults did to the nonsense syllable--the meaning of the word being more discrepant to them than it was for the adults.

<u>Heart Rate</u>

The same procedure was followed in the heart rate phase as that used in the galvanic skin response analysis.

were: .549 and .389. This is consistent with previous findings of greater frequency of response for (younger) children (Bower & Das, 1972).

The main effect obtained here does not correspond with the second by second conductance change and magnitude analyses. As the magnitude change measure was more sensitive to change than was frequency, it was considered to be a more reliable measure. As such the writer believed that it was reasonable to rely on the results obtained in the magnitude analysis.

Habituation of the frequency of responses was observed through the significant main effect obtained for the discrete/massed dimension ($F = 35.30$, $df = 1,70$, $P < .001$). The overall means were .567 and .370 for the discrete/massed presentations respectively. This finding is consistent with the previous finding regarding the effects of repetition, observed in the magnitude analysis. Once again no groups x discrete/massed interaction was evident. Thus the children appear to display habituation of the orienting response as much as the adults do, as measured by the galvanic skin response.

The significant main effect for trials supported the findings obtained in the magnitude analysis.

<u>Summary of GSR Analysis</u>

The overall results of the galvanic skin response phase does not lend support to Hypothesis 2. There were no

An initial check of counterbalancing was made. The results indicated that there were no significant differences in the counterbalanced groups (adults; F= 0.58, df= 1,36; children; F= 0.04, df= 1,36). Therefore the groups were combined for all further heart rate analyses.

As the prestimulus heart rate level affects the amount of deceleration or acceleration that occurs (Graham & Jackson, 1970), a *t* test was performed on the adult-child mean prestimulus level. The results indicated that there were no significant differences in prestimulus mean between the adult and the children groups ($t = 1.88$, $df = 71$, $P > .06$). The variances too were homogeneous ($F = 1.22$, $df = 1,70$, $P > .50$). A further check for effect of prestimulus heart rate was carried out to determine the correlation between prestimulus heart rate and amount of deceleration.

The prestimulus heart rate means of both groups were correlated with the lowest beats per minute obtained in the one to five seconds following onset of the stimulus. As the correlation was not significant, the results obtained in relation to the difference scores are not significantly related to the prestimulus heart rate.

Second by Second Difference Scores

A 2(groups) x 2 (discrete/massed) x 3 (stimuli) x 2 (trials) x 8(seconds) analysis of variance was carried out on the sec x sec difference scores. The last four factors were repeated. The results of the analysis is presented in

Table 4, Figures 4,5,6 present the means of the two groups as well as the massed and discrete conditions.

The results indicated a significant main effect for stimuli ($F= 3.10$, $df= 2,140$, $P< .05$). Subsequently a number of exploratory within--group analyses were undertaken at this point in an attempt to examine more closely the effect of the different types of stimuli within the two groups. As it was believed one group or specific combination of stimuli were giving rise to this effect.

When the tone was omitted from the analysis a significant main effect for stimuli emerged ($F= 5.25$, $df= 1,36$, $P< .05$) for the adult group. The results of this analysis is presented in Table 5. The indication was that the nonsense syllable produced greater acceleration of heart rate than did the word. Thus, the results here support the trend observed in (Figure 6) for the nonsense syllable.

A discrete/massed x seconds interaction was evident in the adult group ($F= 4.192$, $df= 7,252$, $P< .001$) supporting the trends in (Figure 6).

For the children there was no significant main effect for stimuli observed. However, a significant discrete/massed x seconds interaction was evident ($F= 2.53$, $df= 7,252$, $P< .025$). Table 6 presents the results of this analysis. The indication here supported the trend of heart rate from the discrete to the massed presentation observed in Figure 6, in relation to the nonsense syllable and the word. Both stimuli displayed a reversal in general trend, from the

Table 4

Analysis of Variance: Heart Rate sec x sec
Difference Scores

Source	df	M.S.	F-ratio
Between			
Group (A)	1,70	45.37	NS
Error	70	114.81	
Within			
Discrete/massed (DM)	1,70	8.90	NS
DM x A	1,70	15.76	NS
Error	70	107.78	
Stimuli (S)	2,140	373.12	3.10*
S x A	2,140	327.94	2.72
Error	140	120.46	
Trials (T)	1,70	50.36	NS
T x A	1,70	283.56	3.37
Error	70	84.09	
Seconds (SC)	7,490	9.13	NS
SC x A	7,490	9.13	NS
Error	490	12.07	

*P< .05

**P< .01

***P< .001

NOTE: The remainder of the interactions were not significant at the .05 level.

Table 5

Analysis of Variance: Heart Rate sec x sec
Difference Scores (Adults: tone omitted)

Source	df	M.S.	F-ratio
Within			
Discrete/massed (DM)	1,36	14.63	NS
Error	36	95.03	
Stimuli (S)	1,36	362.41	5.24*
Error	36	69.00	
Trials (T)	1,36	2.00	NS
Error	36	62.77	
Seconds (SC)	7,252	17.22	2.50
Error	252	6.89	
DM x SC	7,252	4.19	4.19***
Error	252	4.73	

*P< .05

**P< .01

***P< .001

Table 6

Analysis of Variance Heart Rate sec x sec
Difference Scores (Children: tone omitted)

Source	df	M.S.	F-ratio
Within			
Discrete/massed (DM)	1,36	0.55	NS
Error	36	95.91	
Stimuli (S)	1,36	296.56	NS
Error	36	160.62	
Trials	1,36	0.11	NS
Seconds	1,36	11.79	NS
Error	36	13.13	
DM x SC	7,252	5.19	NS
Error	252	10.38	
S x Sc	7,252	26.11	2.53*
Error	252	10.33	

*P< .05

**P< .01

***P< .001

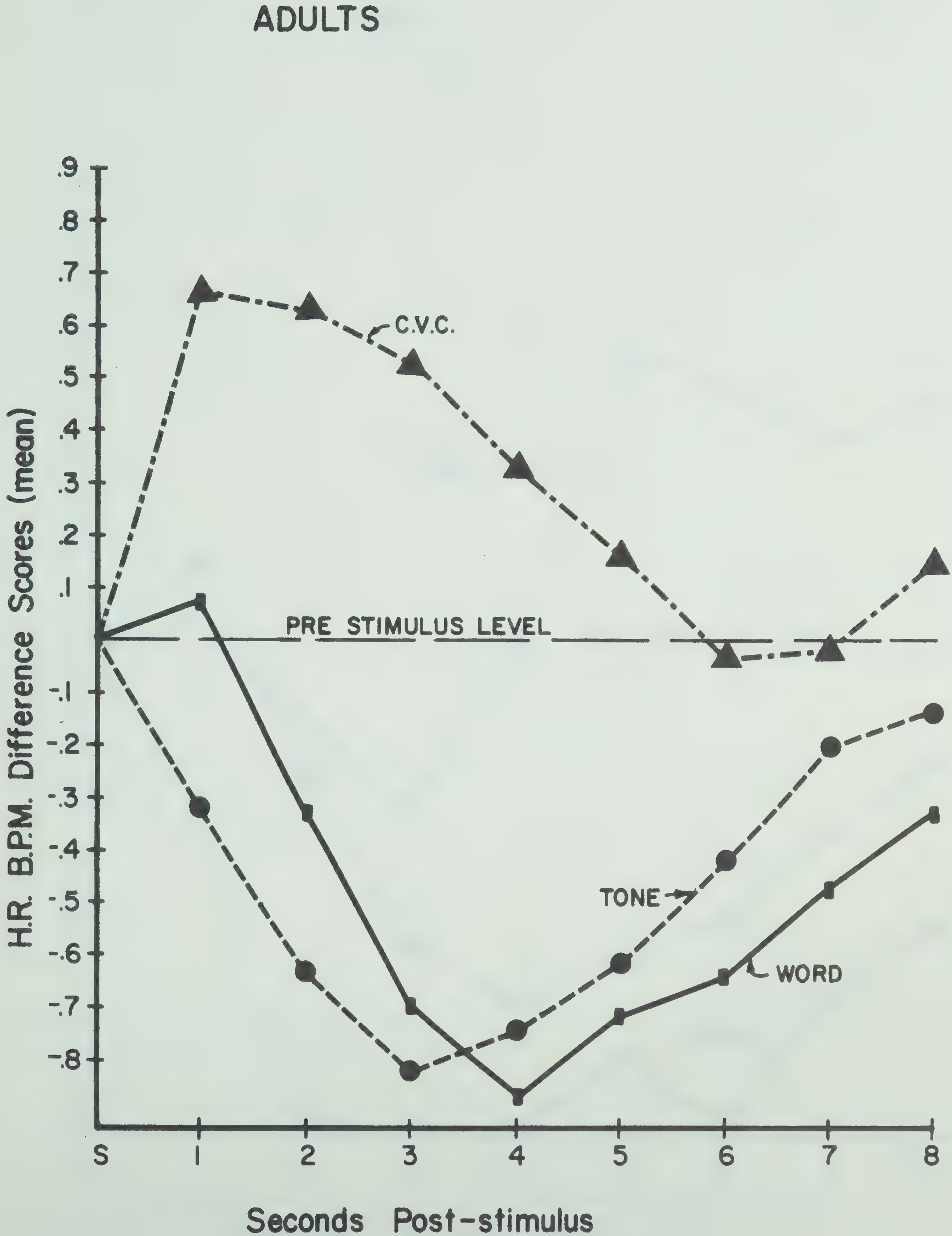
ADULTS
H.R. B.P.M. Difference Scores (mean)
.9
.8
.7
.6
.5
.4
.3
.2
.1
-.1
-.2
-.3
-.4
-.5
-.6
-.7
-.8
C.V.C.
PRE STIMULUS LEVEL
TONE
WORD
S
1
2
3
4
5
6
7
8
Seconds Post-stimulus

Figure 4

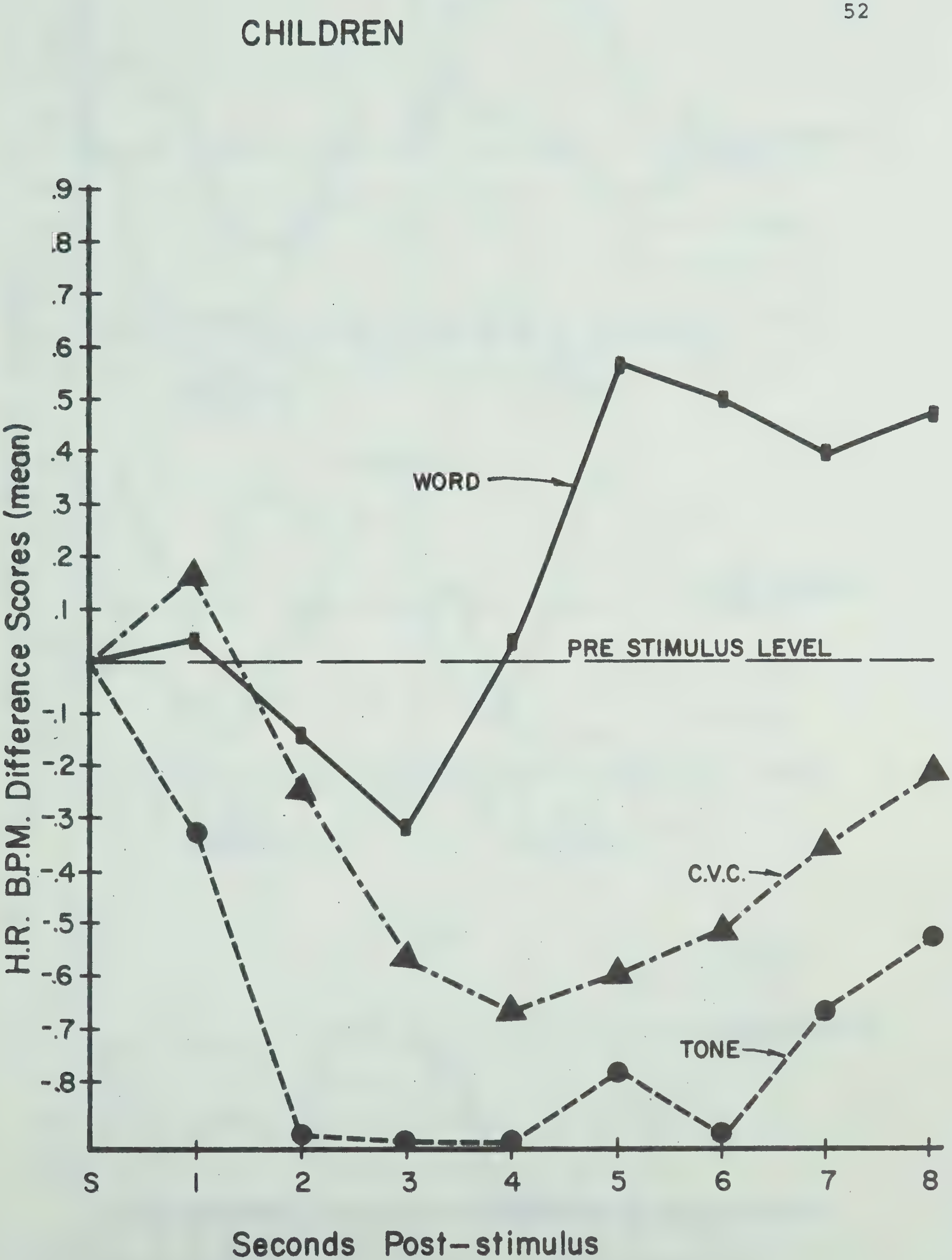
CHILDREN
.9
.8
.7
.6
.5
.4
.3
.2
.1
-.1
-.2
-.3
-.4
-.5
-.6
-.7
-.8
H.R. B.P.M. Difference Scores (mean)
WORD
PRE STIMULUS LEVEL
C.V.C.
TONE
S
1
2
3
4
5
6
7
8
Seconds Post-stimulus

Figure 5

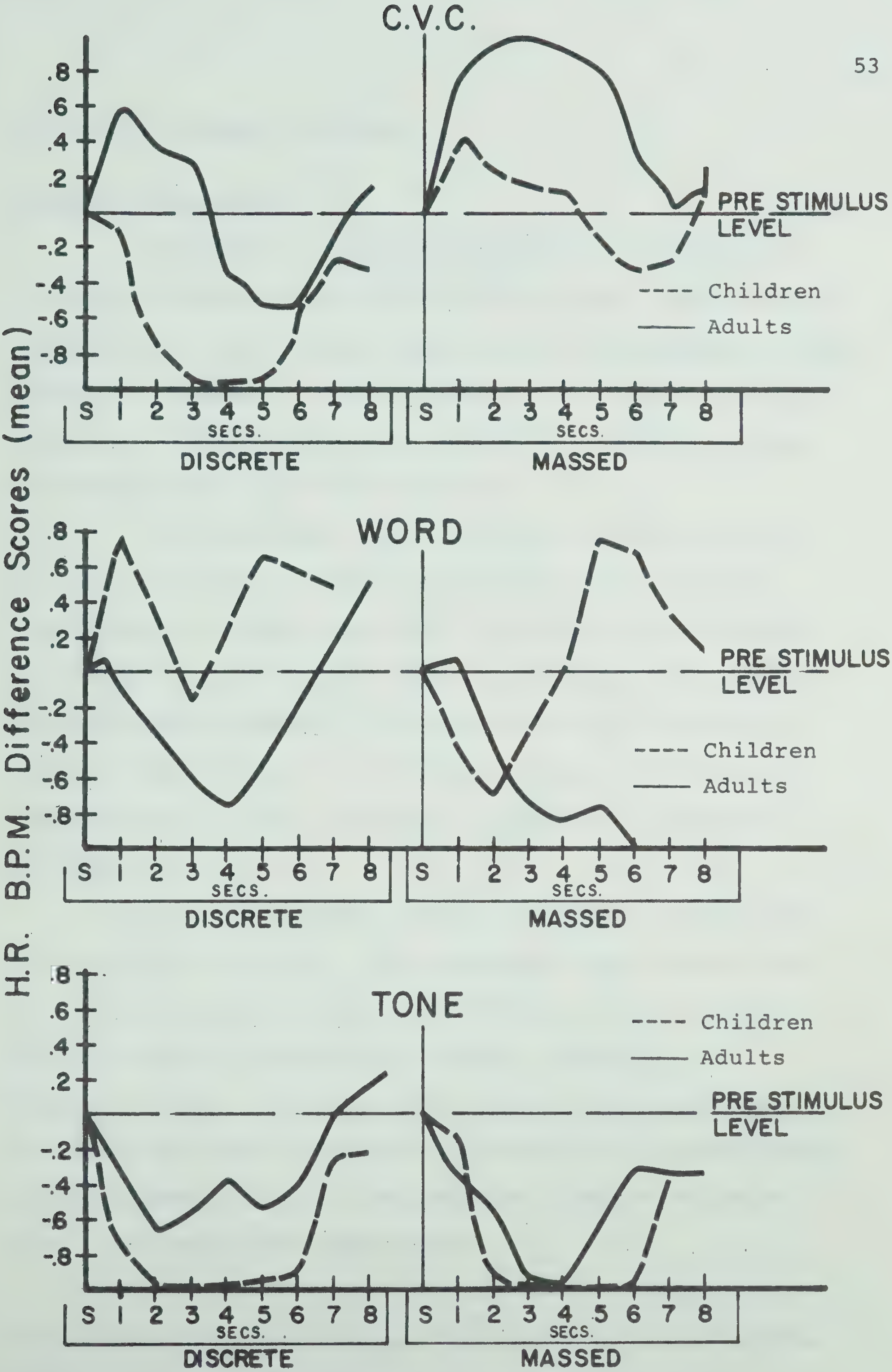
C.V.C.
WORD
TONE
H.R. B.P.M. Difference Scores (mean)
.8
.6
.4
.2
-.2
-.4
-.6
-.8
PRE STIMULUS LEVEL
---- Children
—— Adults
S 1 2 3 4 5 6 7 8
SECS.
DISCRETE
MASSED

Figure 6

discrete to massed condition.

Percent Deceleration

A 2(groups) x 2(discrete/massed) x 3(stimuli) x 2(trials) analysis of variance with the last three factors repeated, was carried out using percent deceleration as the dependent variable. Table 7 presents the results of this analysis. Figure 7 presents the means of the two groups collapsed over trials one and five.

The significant main effect for groups ($F= 5.42$, $df= 1,70$, $P< .01$) indicated a greater overall percent deceleration of heart rate for children than for adults. The means were 3.773 and 2.750 respectively. The effect obtained here appeared to be due largely to the greater percent deceleration to all three stimuli on the forty presentations by the children as compared to the adults (Figure 7).

The trend towards a group x stimulus interaction ($F= 2.53$, $df= 2,140$, $P< .08$) indicated that, whereas the children displayed greater deceleration to the nonsense syllable than to the word the adults reacted in an opposite manner. The means for the word and nonsense syllables for the adults were 2.976 and 2.168 respectively. The childrens means for the word and nonsense syllables were 2.994 and 3.897 respectively.

The adults display habituation of deceleration to the nonsense syllable but not for the word. The children on the other hand display little change in percent decleration of heart rate as a result of repetition of the

Table 7

Analysis of Variance Heart Rate Percent Deceleration

Source	df	M.S.	F-ratio
Between	71		
Groups (A)	1,70	226.11	5.42**
Error	70	41.70	
Within			
Discrete/massed (DM)	1,70	1.57	NS
DM x A	1,70	60.44	2.67
Error	70	22.63	
Stimulus (S)	2,140	58.58	2.53
S x A	2,140	57.34	2.48
Error	140	23.13	
Trials (T)	1,70	0.65	NS
T x A	1,70	10.60	NS
Error	70	18.88	
DM x S	2,140	68.97	2.85
Error	2,140	24.18	

*P< .05

**P< .01

***P< .001

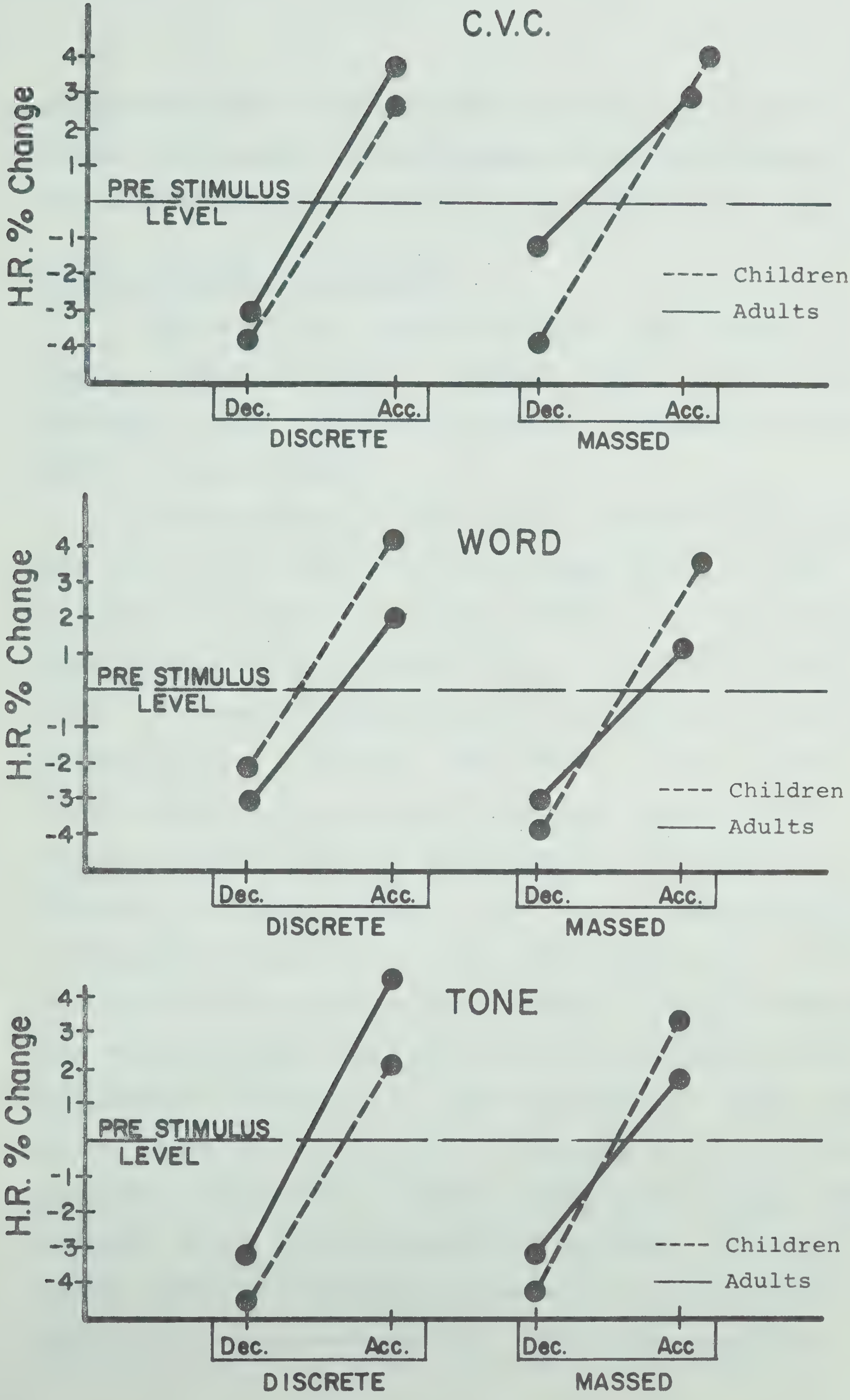
C.V.C.
H.R. % Change
4
3
2
1
PRE STIMULUS LEVEL
-1
-2
-3
-4
---- Children
—— Adults
Dec.
Acc.
DISCRETE
Dec.
Acc.
MASSED
WORD
H.R. % Change
4
3
2
1
PRE STIMULUS LEVEL
-1
-2
-3
-4
---- Children
—— Adults
Dec.
Acc.
DISCRETE
Dec.
Acc.
MASSED
TONE
H.R. % Change
4
3
2
1
PRE STIMULUS LEVEL
-1
-2
-3
-4
---- Children
—— Adults
Dec.
Acc.
DISCRETE
Dec.
Acc
MASSED

Figure 7

nonsense syllable. For the word, however, the children display an increase of acceleration, whereas the adults display little change. This is also indicated in Figure 6.

Summary of Heart Rate Results

The heart rate analyses produced very unusual results. There is a strong indication that the heart rate component of the orientating response is sensitive to the nature of verbal stimuli.

Interpretation of the initial acceleration of heart rate observed for adults to the nonsense syllable, could be taken as a defensive reaction (Graham & Clifton, 1966). However, this would not appear valid in relation to this study. A defensive reaction depends on the intensity of the stimulus (Graham & Clifton, 1966; Myers, 1969). As the present stimulus were verbally presented and both words and nonsense syllables kept at approximately the same levels of loudness, it is appropriate to rule out the possibility of a defensive response here. Heart rate acceleration is also an index of attention to internal events. There is considerable evidence indicating that in certain situations heart acceleration corresponds to cognitive activity (Lacey, 1967; Tursky, Schwartz & Crider, 1970; Schwartz, 1971). If one considers acceleration in terms of cognitive activity, adult responses to the stimuli become much clearer. The acceleration seems then to reflect attention to an unfamiliar stimulus and cognitive activity. The nonsense syllable,

possibly because of it's ambiguity, may continuously intrigue adults who attempt to clear up its meaning.

This fits in with Sokolov's neuronal theory quite well if one considers neuronal models of the word and nonsense syllables. The word, having a much more clearly defined model for the adults than the nonsense syllable, produces fewer "signals of discrepancy." Thus the main response to the word is one of attention to an external event. This could also account for the discrepancy noted in the different reactions in relation to the word between the adults and the children. The children have a less well delineated neuronal model of the word than the adults, as a result of the lack of experience with the word. Thus, they continue to search the model longer than the adults do.

However, this explanation seems to contradict the effect obtained for the nonsense syllable in relation to the children. They did not show any indication of searching for the meaning of the nonsense syllables. One possibility is that the children may have completely disregarded the nonsense syllables, as senseless, whereas the adults more actively searched for some meaning.

The above explanations in regard to the disparity of heart rate responses for the adults and the children in relation to the three different stimuli is at most speculative. The main point that can be made here is that differing levels of meaningfulness of stimuli produces

differing trends in heart rate respones.

Habituation of the heart rate response upon repetition did not occur significantly in this study. Previous studies using verbal stimuli have obtained similar results (Bower & Das, 1972). Thus Hypotheses 1, 2, 3 and 4 are not supported in the heart rate response results in this study, as there was little habituation evident for the three stimuli.

Polarity Difference Scores and Autonomic Responses

A correlation procedure was utilized to detect relationships of subjects' semantic differential, heart rate and galvanic skin responses.

The procedure used was to take the scores obtained on each of the six stimulus conditions and correlate this with percent deceleration of heart rate, percent acceleration of heart rate and magnitude of galvanic skin response. Product moment correlation and coefficients were obtained for each of the stimulus conditions.

The results of this analysis revealed no significant correlation between the polarity difference score on the semantic differential and any of the three measures of the orientating response. Thus the present study does not support Hypothesis V. Little relationship was found between the paper-pencil rating index of semantic satiation and habituation of autonomic responses.

Chapter 6

Summary and Conclusions

Consistent with previous research the galvanic skin response data indicated habituation of the orientating response as a result of stimulus repetition. However, the heart rate data did not indicate habituation. In the views of many writers the orientating response comprises a fairly uniform system of reaction. But the evidence here does not support such a view. Rather, these two components of the orientating response (heart rate and galvanic skin response), appear to be related in a complex manner. Therefore, the support for hypothesis 1 is obtained only in the galvanic skin response data.

The finding in this study, of little or no habituation of the heart rate component of the orientating response, raises some questions regarding the generalizability of heart rate habituation. It may have to be limited to nonverbal stimuli. Results from this study suggests that habituation of heart rate does not occur for meaningful stimuli. To assist in clearing up this issue, experiments employing differing levels of meaningfulness of stimuli, with different age groups are indicated. If one were to take three groups of adults and submit one group to repetition of differing tones, one to words, and the other group to nonsense syllables, the different aspects of heart rate habituation may be made

much clearer. This might also be done for children, where age could be included as an independent variable.

Hypothesis 2, that significant differences would be found, between the adult and children groups, with respect to amount of habituation was not supported by the results. The data from the present study suggests there may be a developmental level, where increases of a habituation with age are no longer observed. A study of habituation, taking into consideration four age groups, in the range of from three to eighteen years, may distinguish more clearly the developmental trend.

Hypothesis 3, that greater habituation would occur for tone, in both groups, was not supported in any of the results. Habituation as a result of repetition of tones was evident in the galvanic skin response data of both groups. However, there were no significant differences found in the amount of habituation for the three types of stimuli. Heart rate again, went its' separate way, displaying no habituation for all three stimuli.

Hypothesis 4, that less habituation of the orientating response would be displayed for the nonsense syllables in both groups was not supported by the data. However, an interesting aspect of the study was observed with respect to the adult and childrens' responses to the nonsense syllables and words. These were obtained most clearly in the heart rate data. The adults displaying

significantly greater acceleration of heart rate to the nonsense syllables than they did to the words or tones. The children, on the other hand, displayed little or no acceleration of heart rate to the nonsense syllables or the tones, but showed considerable heart rate acceleration in response to the words. This may imply that heart rate responses reflect cognitive operations. It would appear that differential heart rate responding may be a powerful technique for investigating an organism's interactions with the environment. Although decreased heart rate to external stimulation has been investigated quite often, the development of the accelerative component associated with thinking, has not been studied in any great detail.

The evidence from the present study suggests that a stimulus which has little or no informational value (such as a pure tone), essentially produces cardiac deceleration. However, stimuli which is somewhat meaningful produce cardiac acceleration (thinking). If one were to make the nonsense syllables contain less ambiguity (less informational value), the results of this study indicate that only cardiac deceleration would occur.

In mental retardates one could expect that the cardiac acceleration component of heart rate may be different for normals of equal CA. The mental retardates would be expected to display greater heart rate acceleration to some stimuli than normals because of a lack of clarity of the meaning. It would be instructive here, to determine when mental

retardates and children first manifest heart rate acceleration during a cognitive operation and what changes this undergoes as the childrens' cognitive processes mature.

To help map cognitive development, tasks which increase in cognitive difficulty could be administered and one might note where initial heart rate acceleration begins. Through this an index of rate of cognitive development might be derived. The results could produce a reliable measure of cognitive functioning, which may be utilized with very young children and the mentally retarded, where the majority of the present measures are inapplicable.

The question of semantic satiation as habituation of the orientating response, was not resolved in this study. Hypothesis 5 that there would be significant correlations between the semantic satiation and autonomic response measures was not borne out. To more clearly determine the relationship here, the group of adults might be divided into high and low satiators and examine their decrease in autonomic responsivity as a result of repetition. High satiators would be expected to display greater decrease in autonomic responsivity as a result of repetition of verbal stimuli than would the low satiators. This investigation could be carried out utilizing the data from the present study.

In conclusion the data from the present study indicates habituation of the orientating response as a result of repetition. Further, habituation occurs as a result of repetition, regardless of the types of stimuli

employed or whether one uses a satiation or habituation paradigm. There is also indication in the present study, that exploration of the heart rate component of the orientating response, may prove a viable approach to the study of cognitive functioning.

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Appendix A

Semantic Differential

Scale

Name ______________________________ Word Yuf

very quite some some quite very

Good /-------/-------/-------/-------/-------/-------/-------/ Bad

Beautiful /-------/-------/-------/-------/-------/-------/-------/ Ugly

Pleasant /-------/-------/-------/-------/-------/-------/-------/ Unpleasant

Name ______________________________ Word Zuk

very quite some some quite very

Good /-------/-------/-------/-------/-------/-------/-------/ Bad

Beautiful /-------/-------/-------/-------/-------/-------/-------/ Ugly

Pleasant /-------/-------/-------/-------/-------/-------/-------/ Unpleasant

Name ______________________________ Word _____Love_____

very quite some some quite very

Good /-------/-------/-------/-------/-------/-------/-------/ Bad

Beautiful /-------/-------/-------/-------/-------/-------/-------/ Ugly

Pleasant /-------/-------/-------/-------/-------/-------/-------/ Unpleasant

Name ______________________________ Word _____Friend_____

very quite some some quite very

Good /-------/-------/-------/-------/-------/-------/-------/ Bad

Beautiful /-------/-------/-------/-------/-------/-------/-------/ Ugly

Pleasant /-------/-------/-------/-------/-------/-------/-------/ Unpleasant

Name ______________________________ Word 600 cps Tone

```
          very    quite    some              some    quite    very
Good      /-------/-------/-------/-------/-------/-------/-------/ Bad

Beautiful /-------/-------/-------/-------/-------/-------/-------/ Ugly

Pleasant  /-------/-------/-------/-------/-------/-------/-------/ Unpleasant
```

Name ______________________________ Word 1000 cps Tone

```
          very    quite    some              some    quite    very
Good      /-------/-------/-------/-------/-------/-------/-------/ Bad

Beautiful /-------/-------/-------/-------/-------/-------/-------/ Ugly

Pleasant  /-------/-------/-------/-------/-------/-------/-------/ Unpleasant
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Appendix B

Materials Utilized to Minimize

Electrode Polarization

Materials Utilized to Minimize Electrode Polarization

The techniques utilized to prevent electrode polarization, in this study, followed those suggested by Martin (1964).

1. A two-element electrode was utilized (one to carry the constant current, the other to act as a voltage probe).

2. Beckman electrode paste consisting essentially of Na Cl was used.

3. Electrodes were constructed of silver-silver chloride.

The above materials reduce but do not completely eliminate electrode polarization.